

CATHELCO LTD

BALLAST WATER MANAGEMENT SYSTEM

Section 4.5 Summary of Ship-based tests

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4.5.1 Introduction

The ship-board tests have been carried out on the MV Eddystone by the staff of MEA-nl from November 2012 to April 2013 at the positions indicated in the table below.

Date	Tank no.	Operation	Tank vol. start [m³]	Tank vol. end [m³]	Location	Position		Retention time [days]
						LAT	LON	
13-11-2012	9+10 Treated	Ballasting	84,31	332,00	Gran Canaria (ES)	32°44,2 N	13°44,6 W	3
13-11-2012	5+6 Control	Ballasting	48,94	226	Gran Canaria (ES)	33°18,9 N	13°33,6 W	
16-11-2012	9+10 Treated	De-Ballasting	332	67,74	Marchwood (UK)	50° 20.0'N	02° 30.0'W	
16-11-2012	5+6 Control	De-Ballasting	226	48,78	Marchwood (UK)	50° 53.6'N	02° 24.7'W	
11-01-2013	9+10 Treated	Ballasting	57,09	318,21	Marchwood (UK)	50° 53.6'N	01° 25.3'W	4
11-01-2013	7+8 Control	Ballasting	75,39	341,51	Marchwood (UK)	50° 53.6'N	01° 25.3'W	
16-01-2013	9+10 Treated	De-Ballasting	332	92,7	Gibraltar (UK)	36° 01.3N	03° 21.0'W	
16-01-2013	7+8 Control	De-Ballasting	341,51	70,29	Gibraltar (UK)	36° 06.5'N	05° 20.8'W	
28-02-2013	9+10 Treated	Ballasting	53,30	374,40	Marchwood (UK)	50° 53.7'N	01° 25.7'W	3
28-02-2013	3+4+16 Control	Ballasting	39	284,26	Marchwood (UK)	50° 53.7'N	01° 25.2'W	
03-03-2013	9+10 Treated	De-Ballasting	374,40	96,11	Marchwood (UK)	50° 53.7'N	01° 25.2'W	
03-03-2013	3+4+16 Control	De-Ballasting	214,66 (284,26)	26,12	Marchwood (UK)	50° 53.7'N	01° 25.2'W	
18-04-2013	9+10 Treated	Ballasting	46,32	322,56	Gran Canaria (ES)	27° 43.8'N	15° 22.7'W	3
18-04-2013	16 Control	Ballasting	64,92	216,55	Gran Canaria (ES)	28° 08.7'N	15° 24.0'W	
21-04-2013	9+10 Treated	De-Ballasting	322,56	54,5	Coast of France	48° 23.4'N	05° 20.4'W	
21-04-2013	16 Control	De-Ballasting	216,55	31,36	Coast of France	48° 28.1'N	5° 20.4'W	
23-04-2013	9+10 Treated	Ballasting	53,11	333,22	Entrance of the English channel (near Brest)	49° 11.2'N	04° 32.9'W	5
23-04-2013	16 Control	Ballasting	13,87	193,32	Entrance of the English channel (near Brest)	49° 21.2'N	04° 06.6'W	
28-04-2013	9+10 Treated	De-Ballasting	333,22	112,36	Marchwood (UK)	48° 11.0'N	06° 05.0'W	
28-04-2013	16 Control	De-Ballasting	193,32	37,09	Marchwood (UK)	50° 53.0'N	01 25.3'W	

A total of five tests were conducted over the six months trial period. Summary tables of the test results are provided as extracts from the relevant report of the test institute. For details of the ship-based tests see the report from MEA-nl (Annex 2b).

4.5.2 Water quality conditions during the ship-based tests

All tests were done under marine conditions. The water quality varied according to the table below:

variable	range	unit
Salinity	33.36 – 37.13	g/kg (PSU)
DOC	n/a	mg/L
POC	1 – 3.7	mg/L
TSS	0.95 – 14.4	mg/L
Temperature	5.5 - 22	°C
UV-T*	73 - 98	%
Organisms $\geq 50\mu\text{m}$	700-10925	per m ³
Organisms $10\leq\mu\text{m}\leq 50$	8 - 248	Per mL

* UV-T data from Cathelco BWMS log files

4.5.3 Results of the biological efficacy tests

The biological tests were conducted according to the requirements of the IMO G8 test guideline. Test run no. 5 had to be rejected due to an operator fault. An amount of about 50m³ of untreated water were pumped into tank no. 9 after the treated intake during the test run. This water contaminated the test tank (see Annex 2b, 3.5 for details).

The remaining four tests were all considered valid. The average concentrations of organisms at intake and at discharge are summarized in the table below:

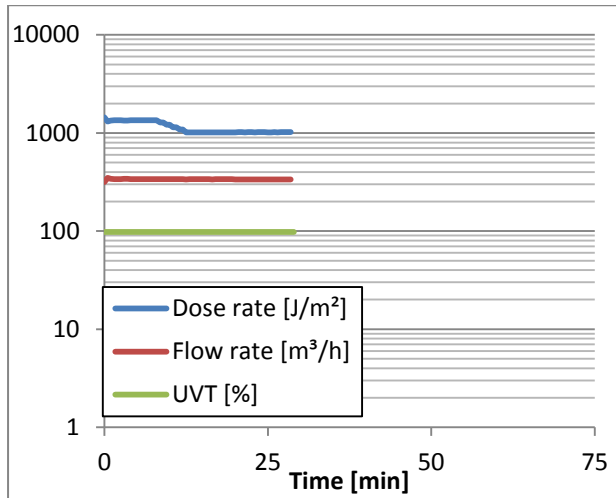
Shipboard test (4 tests)	Test water (T0)		Control (discharge)		Treated (discharge)		unit
	average	min-max	average	min-max	average	min-max	
Organisms $\geq 50\mu\text{m}$	4133	700 - 10925	2040	250 - 7850	1.5	0-4	Per m ³
Organisms $10\leq\mu\text{m}\leq 50$	115.23	8 - 248	53.08	4 - 178	8.55	0 - 17*	Per ml
Heterotrophic bacteria	9.5	6.1 – 12	11.7	6.9 – 16	10.5	6.9 - 13	X100,000 per ml
E. coli	n/a	n/a	n/a	n/a	n/a	n/a	Cfu/100 ml
Enterococci	n/a	n/a	n/a	n/a	n/a	n/a	Cfu/100 ml

* Phytoplankton cells were identified as non-viable by additional PAM measurements.

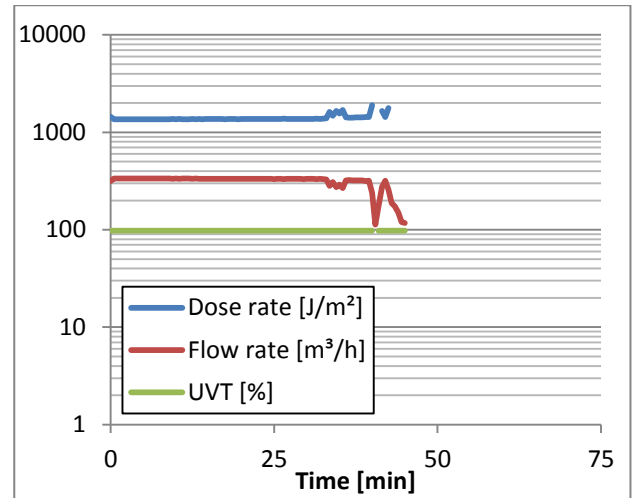
The operational parameters of the system were logged automatically during each of the tests. In addition, pressure values in front of the filter and after the filter were recorded during the 2nd test.

SUMMARY OF G8 TYPE APPROVAL TEST (Ship Based)

Shipboard test S1 – 13.11.2012 to 16.11.2012



UV treatment during uptake of Shipboard test S1.



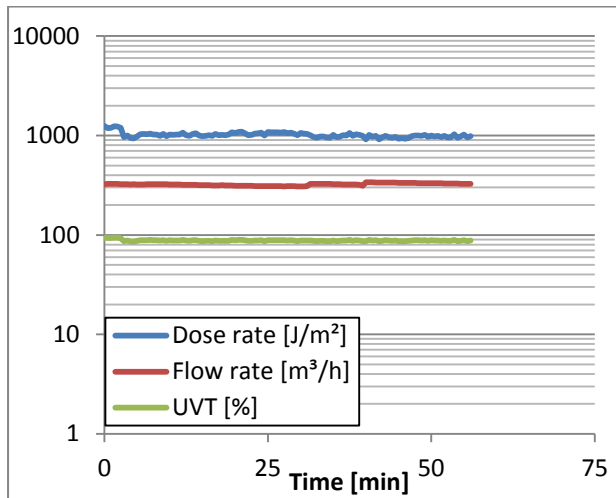
UV treatment during discharge of Shipboard test S1.

Summary of Shipboard test S1. Averages of salinity, temperature and TSS as well were the operational parameters from Cathelco BWMS log files. Abundances of organisms > 50µm are included. For full biological results see the report from MEA-nl (Annex 2b).

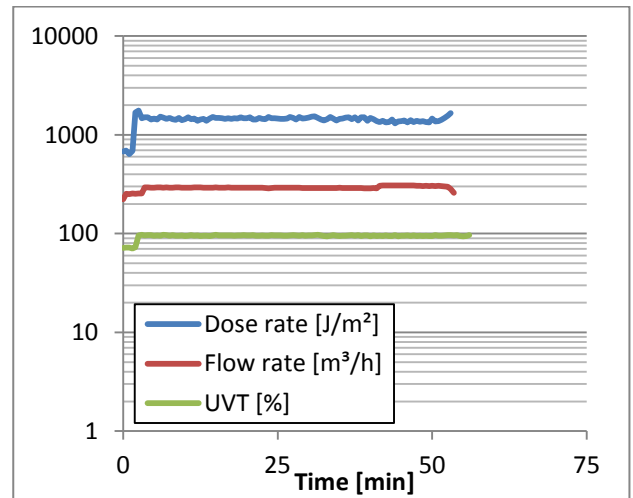
Uptake (T0)	Sal [PSU]	Temp [°C]	TSS [mg/l]	Org. >50µm [org./m³]	Flow rate [m³/h]	Filter back- flushes	UVT [%]	UV dose [J/m²]	P - UV [KW]	Dis- charge (T5)	Sal [PSU]	Temp [°C]	TSS [mg/l]	Org. >50µm [org./m³]	Flow rate [m³/h]	UVT [%]	UV dose [J/m²]	P – UV [KW]
Control	n/a	21,2	4,05	725	n/a	n/a	n/a	n/a	n/a	Control	37,99	14,4	5,38	550	n/a	n/a	n/a	n/a
Treated	n/a	21,7	3,36	0	336		98	577	59,86	Treated	33,94	14,1	5,55	2	313	98	709	65,49

SUMMARY OF G8 TYPE APPROVAL TEST (Ship Based)

Shipboard test S2 – 11.01.2013 to 16.01.2013



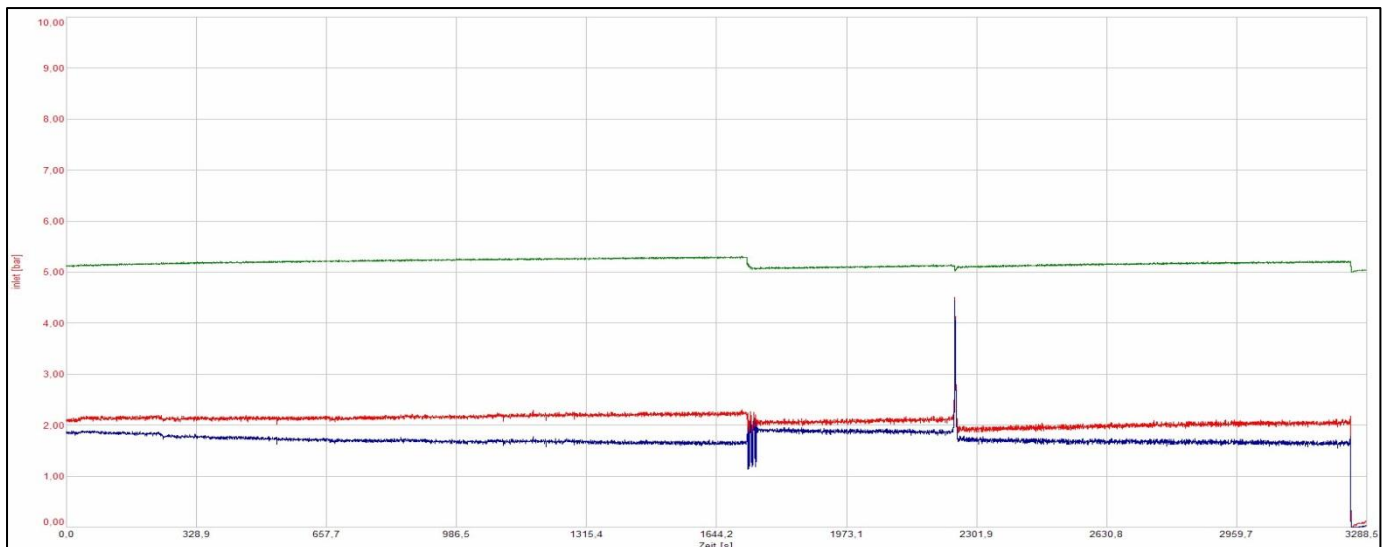
UV treatment during uptake of Shipboard test S2.



UV treatment during discharge of Shipboard test S2.

Summary of Shipboard test S2. Averages of salinity, temperature and TSS as well were the operational parameters from Cathelco BWMS log files. Abundances of organisms > 50µm are included. For full biological results see the MEA report (Annex 2b).

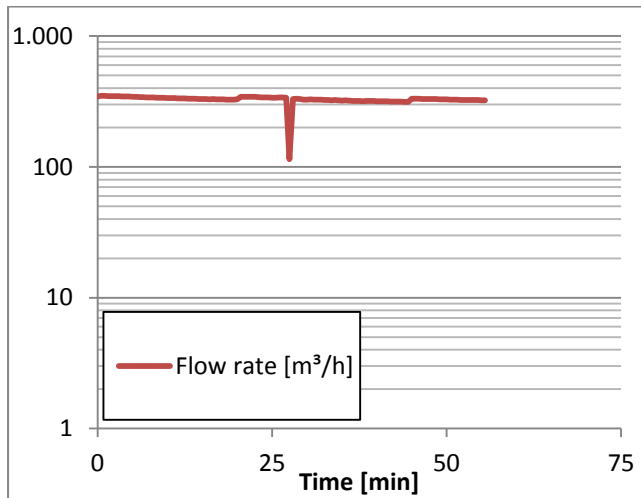
Uptake (T0)	Sal [PSU]	Temp [°C]	TSS [mg/l]	Org. >50µm [org./m³]	Flow rate [m³/h]	Filter back-flushes	UVT [%]	UV dose [J/m²]	P – UV [KW]	Dis-charge (T5)	Sal [PSU]	Temp [°C]	TSS [mg/l]	Org. >50µm [org./m³]	Flow rate [m³/h]	UVT [%]	UV dose [J/m²]	P – UV [KW]
Control	30,64	9	19,6	9908	n/a	n/a	n/a	n/a	n/a	Control	32,48	15,8	3,4	6433	n/a	n/a	n/a	n/a
Treated	30,36	9,9	9,2	3	322	2	88	514	65,48	Treated	31,5	16,4	5,6	3	286	95	740	65,45



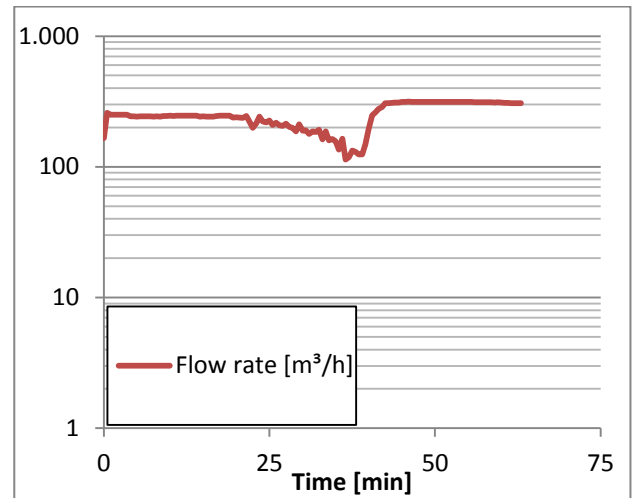
Filter operation during uptake of Shipboard test S2. Green - Differential pressure; red - pressure before filter; blue - pressure after filter.

SUMMARY OF G8 TYPE APPROVAL TEST (Ship Based)

Shipboard test S3 – 28.02.2013 to 03.03.2013



Flow rate during uptake of Shipboard test S3.



Flow rate during discharge of Shipboard test S3.

Summary of Shipboard test S3. Averages of salinity, temperature and TSS as well were the operational parameters from Cathelco BWMS log files. Abundances of organisms > 50µm are included. For full biological results see the MEA report (Annex 2b).

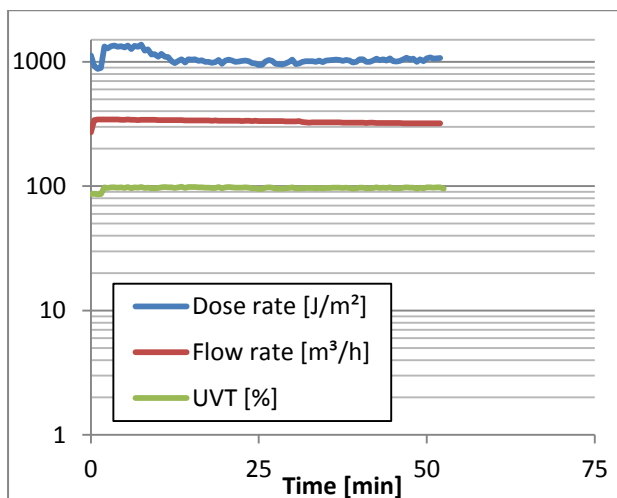
Uptake (T0)	Sal [PSU]	Temp [°C]	TSS [mg/l]	Org. >50µm [org./m³]	Flow rate [m³/h]	Filter back-flushes	UVT [%]	UV dose [J/m²]	P - UV [KW]	Dis-charge (T5)	Sal [PSU]	Temp [°C]	TSS [mg/l]	Org. >50µm [org./m³]	Flow rate [m³/h]	UVT [%]	UV dose [J/m²]	P – UV [KW]
Control	34,1	5,3	10,8	3758	n/a	n/a	n/a	n/a	n/a	Control	36,0	8,9	7,8	350	n/a	n/a	n/a	n/a
Treated	32,6	5,6	12,0	1	331	n/a	(27*)	1000	65,44	Treated	32,1	7,2	7,7	1	249	(27*)	997	63,42

* Insufficient cleaning of the UV-T sensor resulted in false readings.

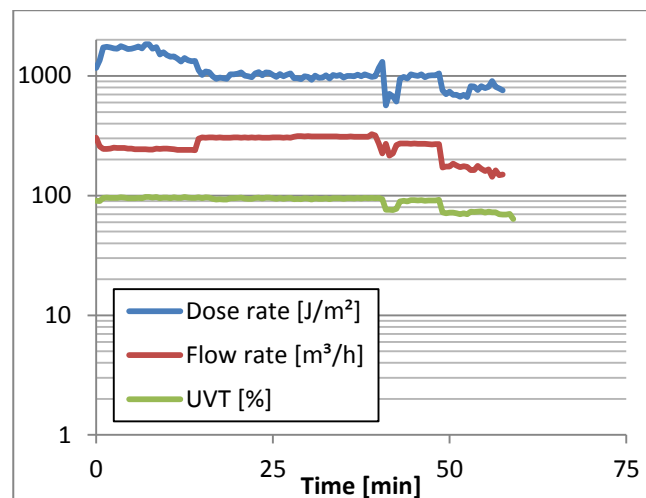
An average UV dose has been assessed from the readings of the UV intensity meters in relation to the flow condition.

SUMMARY OF G8 TYPE APPROVAL TEST (Ship Based)

Shipboard test S4 – 18.04.2013 to 21.04.2013



UV treatment during uptake of Shipboard test S4.



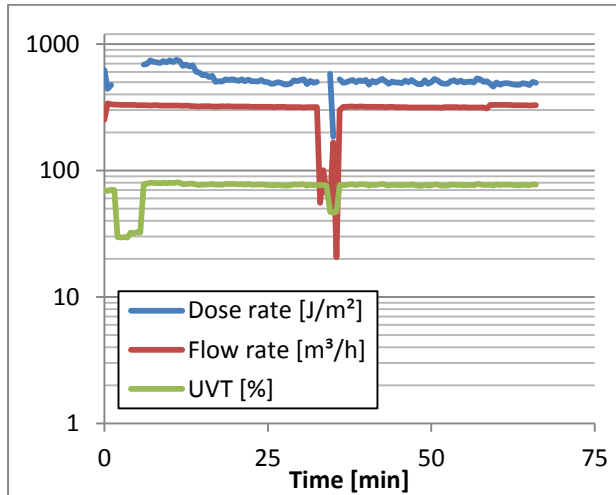
UV treatment during discharge of Shipboard test S4.

Summary of Shipboard test S4. Averages of salinity, temperature and TSS as well were the operational parameters from Cathelco BWMS log files. Abundances of organisms > 50µm are included. For full biological results see the MEA report (Annex 2b).

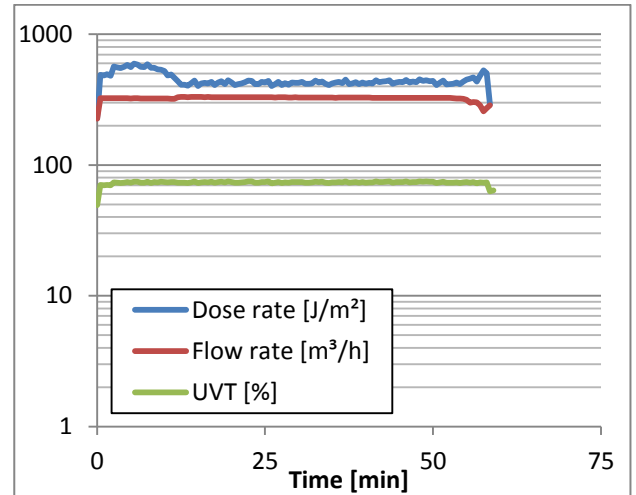
Uptake (T0)	Sal [PSU]	Temp [°C]	TSS [mg/l]	Org. >50µm [org./m³]	Flow rate [m³/h]	Filter back- flushes	UVT [%]	UV dose [J/m²]	P - UV [KW]	Dis- charge (T5)	Sal [PSU]	Temp [°C]	TSS [mg/l]	Org. >50µm [org./m³]	Flow rate [m³/h]	UVT [%]	UV dose [J/m²]	P – UV [KW]
Control	36,3	19,7	2,3	2142	n/a	n/a	n/a	n/a	n/a	Control	37,8	16,4	3,9	825	n/a	n/a	n/a	n/a
Treated	36,8	20,0	1,7	2	331	1	97	1060	58,48	Treated	35,7	16,9	7,8	1	264	90	1104	58,37

SUMMARY OF G8 TYPE APPROVAL TEST (Ship Based)

Shipboard test S5 – 23.04.2013 to 28.04.2013



UV treatment during uptake of Shipboard test S5.



UV treatment during discharge of Shipboard test S5.

Summary of Shipboard test S5. Averages of salinity, temperature and TSS as well were the operational parameters from Cathelco BWMS log files. Abundances of organisms > 50µm are included. For full biological results see the MEA report (Annex 2b).

Uptake (T0)	Sal [PSU]	Temp [°C]	TSS [mg/l]	Org. >50µm [org./m³]	Flow rate [m³/h]	Filter back-flushes	UVT [%]	UV dose [J/m²]	P - UV [KW]	Dis-charge (T5)	Sal [PSU]	Temp [°C]	TSS [mg/l]	Org. >50µm [org./m³]	Flow rate [m³/h]	UVT [%]	UV dose [J/m²]	P – UV [KW]
Control	35,8	10,3	2,9	5342	n/a	n/a	n/a	n/a	n/a	Control	38,0	10,6	2,5	3308	n/a	n/a	n/a	n/a
Treated	36,4	10,9	3,0	0	310	0	74	531	58,78	Treated	38,1	11,4	2,1	25	324	73	448	58,42

* Treated test tank no. 9 has been contaminated with 50m³ of untreated water (see Annex 2b, 3.5 for details)

END PAGE

Revision	Date	Description	Author	Checked	Approved
02	04/10/2013	Grammar corrections, Correction of title	PH	RF	MD
01	01/10/2013	Changed summary tables	PH		
00	13.09.2013	Initial Issue	MV		